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Effect of preoperative continuous positive airway pressure duration on outcomes after maxillofacial surgery for obstructive sleep apnoea

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Abstract

Continuous positive airway pressure (CPAP) remains the first-line treatment for obstructive sleep apnoea (OSA), and is known to result in various physiological changes. The objective of this study was to evaluate the association between duration of preoperative CPAP therapy and outcome after maxillomandibular advancement (MMA) for OSA. We retrospectively analysed consecutive patients treated at our institution, and divided them into 2 groups based on duration of treatment with CPAP: short-term (up to 12 months) and long-term use (12 months or more). We controlled for baseline demographic and clinical characteristics. We compared postoperative scores for the apnoea/hypopnoea index (AHI) and the Epworth sleepiness scale (ESS), and lowest recorded oxygen saturation between groups. In 43 patients data were available on the preoperative use of CPAP, and in 37 of them preoperative and postoperative polysomnographic data were also available for inclusion. Most had bimaxillary advancement with genioplasty. Differences between the groups in mean reduction in the AHI and lowest oxygen saturation were not significant, and operative success rates were comparable. After operation, the reduction in ESS scores was significantly greater in the long-term group than in the short-term group (mean (SD) 8(3) compared with 2 (2), respectively, $p < 0.001$). Our results suggest that the duration of use of CPAP preoperatively does not significantly influence objective outcome measures. The reduction in AHI scores after MMA was equivalent in both groups. The long-term group seemed to fare better than the short-term group on subjective outcome measures.

Keywords: Maxillomandibular advancement; CPAP duration; Surgical outcomes; Maxillofacial surgery; Obstructive sleep apnoea (OSA)

Introduction

Obstructive sleep apnoea (OSA) has a documented prevalence of 5% in the adult population, and is known to cause considerable morbidity and associated mortality. It is characterised by repeated obstruction of the upper airway during sleep as a result of loss of pharyngeal muscle tone, and has a strong association with sudden cardiac death, stroke, mood disorders, and road traffic accidents.[1–3]

Continuous positive airway pressure (CPAP) has been the first-line treatment worldwide since it was first described in 1981,[4] and provides pneumatic splinting of the upper airway. Its benefit in OSA has been documented extensively, but long-term adherence remains a considerable problem for patients, and studies have reported non-compliance of around 40%.[5,6]

Recently, a European Respiratory Society working group identified the need to develop alternative treatments to help manage the increasing burden of morbidity. It concluded that maxillomandibular advancement was as effective as CPAP and could be suggested for patients who are unable to tolerate long-term, non-invasive interventions.[7]

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Treatment with CPAP is not physiologically neutral. The emergence of central apnoea in some patients with OSA after treatment is started has been well described and is thought to be mediated by CPAP-induced impairment of chemoreceptors involved in respiratory control.[8] CPAP is known to reduce the work of breathing, and in patients who have adhered to treatment for a prolonged period of time, may have undergone a degree of respiratory muscle function modification. Positive pressure ventilation has also been shown to cause changes in the lower airway, namely, bronchial inflammation and hyperreactivity of the airway, with variable clinical manifestation in patients.[9,10]

It is currently uncertain if patients who have been receiving long term CPAP therapy who wish to explore surgery as definitive treatment option, would respond differently compared with those who failed to trial or tolerate CPAP for a significant period. Currently, there is limited evidence on which to base the selection of cases and to predict postoperative outcome.

Maxillomandibular advancement is associated with high surgical success, and most patients no longer need to use CPAP postoperatively.[11,12,13] In long-term adherent patients this would represent an abrupt cessation of their CPAP therapy. In view of the physiological changes associated with long term CPAP treatment, could the preoperative duration influence the postoperative individual outcome? We aimed to evaluate the possible association between preoperative duration of treatment with CPAP and outcome after maxillomandibular advancement for OSA. To our knowledge this study is the first to explore this association, and the information will be useful for referring clinicians and surgeons who operate on these patients.

Method

We retrospectively analysed a consecutive group of patients who had maxillomandibular advancement for OSA at our institution between 2002 and 2012. They had all been diagnosed with OSA after clinical investigation and diagnostic sleep study, and had subsequently failed to comply with or tolerate, or had wished to discontinue, use of CPAP and other non-invasive treatments. We retrieved relevant data from the medical records, including characteristics, medical history, and clinical and operative details, as well as data from sleep studies done before and after operation.

Patients were included if they had a confirmed diagnosis of OSA and had used CPAP before operation for a known duration. Data on preoperative sleep studies and those done no less than 6 months postoperatively were also included. Patients who had not tried CPAP, or whose use of it could not be verified, and those with incomplete sleep study data, were excluded. Patients were divided into 2 groups based on the duration of use of CPAP before operation: long-term (12 months or more) and short-term use (under 12 months).

Our predictor variable was long-term compared with short-term use of CPAP before operation and our primary outcome variable was postoperative apnoea/hypopnoea index (AHI) scores. Secondary outcome variables were postoperative Epworth sleepiness scores (ESS) and values for lowest recorded oxygen saturation.

The AHI is an objective measure of disordered breathing during sleep and is calculated from a sleep study. The number of periodic reductions (hypopnoea) or cessations (apnoea) in breathing secondary to obstruction of the upper airway is used to assess the severity of the condition. The ESS is a validated questionnaire used for the subjective assessment of daytime sleepiness in patients with OSA. They are asked to rate the likelihood of dozing in 8 situations, and possible total scores range from 0 to 24 (normal range 0–10).

In our study we considered surgical success to be a postoperative AHI score of less than 15 and a 50% reduction in the AHI from baseline. Postoperative sleep studies were carried out no less than 6 months after operation.

Data were analysed with the help of SPSS Statistics for Windows version 17.0 (SPSS Inc, Chicago). Bivariate analysis was done to measure the association between postoperative sleep study data and duration of use of CPAP. Independent sample *t* tests were used to evaluate differences in continuous variables and the chi square test to compare categorical variables. Probabilities of less than 0.05 were considered significant.

Results

We identified 51 patients who had had maxillomandibular advancement for OSA during the study period. A total of 43 had data available regarding preoperative duration of treatment with CPAP: 19 (44%) had used it for a short term and 24 (56%) for a long term. Data on sleep studies were available in 37.

The baseline characteristics of both groups stratified by duration of CPAP are shown in Table 1. Differences in baseline characteristics, preoperative AHI or ESS scores, or lowest recorded oxygen saturation were not significant. Table 2 shows clinical data and information relating to the extent of maxillomandibular advancement in both groups. Results of the analysis of outcome variables (AHI, ESS and oxygen saturation) when stratified by short-term and long-term preoperative use of CPAP are shown in Table 3.All our patients except one reported a subjective improvement in symptoms after operation. There was a significant difference between mean postoperative ESS scores with the greatest reduction being in the long-term group ($p < 0.001$). Improvement in oxygen saturation nadir following surgery was comparable in both groups and the difference in the rate of surgical success between groups (AHI of less than 15) was not significant.

Table 1
Baseline characteristics of the study sample. Data are number (%) unless otherwise stated.

	Short-term group ($n=19$)	Long-term group ($n=24$)	p Value
Mean (SD) age (years)	46 (7)	43 (7)	0.31
Sex			0.69
Male	18	22	–
Female	1	2	–
Mean (SD) body mass index	28 (4)	29 (4)	0.65
Smokers	7 (37)	7 (29)	0.59
Alcohol	14 (74)	19 (79)	0.67
ASA (1 and 2)	15 (79)	18 (75)	0.22
Mallampati score (class I and II)	10 (53)	18 (79)	0.12
Coexisting conditions	9 (47)	8 (33)	0.35
Previous operation	9 (47)	8 (33)	0.35
Mean (SD) apnoea/hypopnoea index	43 (15)	42 (20)	0.86
Mean (SD) Epworth sleepiness scale	13 (5)	15 (4)	0.13
Mean (SD) lowest oxygen saturation (%)	74 (13)	76 (9)	0.54

ASA: American Society of Anesthesiologists' physical status classification.

Table 2
Orthognathic data of the study sample.

	Short-term group ($n=19$)	Long-term group ($n=24$)	p Value
Malocclusion			0.36
Class I	11	17	
Class II	8	6	
Edentulous	0	1	
Procedure			0.31
Bimaxillary advancement with genioplasty	16	23	
Bilateral sagittal split osteotomy	0	1	
Bimaxillary operation	3	1	
Mean (SD) maxillary advancement (mm)	8.0 (2)	8.4 (2)	0.50
Mean (SD) mandibular advancement (mm)	8.4 (2)	8.2 (2)	0.73

Table 3
Comparison of preoperative and postoperative outcome measures when stratified by duration of use of continuous positive airway pressure (CPAP). Data are mean (SD).

Postoperative scores	Short-term group	Long-term group	p Value
Apnoea/hypopnoea index	10 (6)	6 (3)	0.50
Epworth sleepiness scale	8 (3)	2 (2)	<0.001
Lowest oxygen saturation (%)	82 (6)	83 (7)	0.91

Discussion

We set out to explore the possible association between preoperative duration of treatment with CPAP and surgical outcome after maxillomandibular advancement for OSA. To our knowledge, this is the first study to do so.

CPAP remains the first-line treatment for OSA, but reports of physiological changes (modification of the respiratory muscles and effects on the lower airway) in a proportion of patients may affect how well they respond clinically following operative intervention.

There is no widely accepted definition of long-term CPAP in terms of a specified period of time. To stratify patients, we selected a 12-month cut-off for duration of preoperative use. Yang et al[14] explored the potential neurocognitive effects of the withdrawal of CPAP treatment in patients on an established regimen, and used a minimum of 12 months to define long-term use. Studies exploring the modification of cardiovascular risk with long-term CPAP use have also chosen a similar cut-off period.[15]

Our study showed no significant difference between groups in the primary outcome variable when stratified by duration of preoperative CPAP, and rates of surgical success were comparable. The results suggest that maxillomandibular advancement is an effective treatment irrespective of the duration of preoperative CPAP.

The difference in minimum oxygen saturation between the groups postoperatively was not significant, but there was a significant difference in the mean ESS score ($p<0.001$). Patients in the long-term group seemed to have a significantly greater subjective improvement in their symptoms, and this could possibly be because they have persevered despite the inherent discomfort associated with nocturnal use of CPAP. It could be hypothesised that when it is discontinued after definitive maxillofacial surgery, they may perceive a greater overall benefit which is reflected in their scoring of daytime somnolence. It is noteworthy that both groups were matched in terms of preoperative AHI and ESS scores. Other reports have highlighted a poor correlation between objective and subjective measures of OSA at the diagnostic stage and after uvulopalatopharyngoplasty.[16] Currently, we know of no study that has examined this phenomenon in the context of maxillomandibular advancement.

We re-examined the outcome measures 6 months after operation. The long-term durability of improvements in the AHI after maxillomandibular advancement has been well documented,[17,18] but the long-term reduction in ESS scores after operation is open to question. Currently, we know of few studies that have examined this topic in a surgical group. The ESS has been shown to have high test–retest reliability, and Johns[19] concluded that the scores do not seem to vary significantly across several months when levels of daytime

sleepiness can be expected to remain constant. It seems reasonable to conclude that our group, having recovered from their operations, would therefore be a similarly stable population for the purposes of sampling. Further research would be required to investigate this question formally.

Importantly, most of our sample met the inclusion criteria for long-term use of CPAP. They had persisting daytime somnolence that was manifested by high preoperative ESS scores. As such, they remained symptomatic despite gold standard treatment with CPAP under the auspices of a sleep clinic. They were also counselled about the modification of important aggravating factors such as body weight, and intake of alcohol. The long-term group could therefore be said to be in greatest need of an alternative method of treatment. Our study shows that maxillomandibular advancement is an effective surgical option for patients who are experiencing ongoing problems because of daytime sleepiness.

The confounding variables in our study include the threshold at which a patient can be classified as being a long-term user of CPAP. Additionally, adherence to treatment will inevitably vary between patients. When discussing a subjective value such as the ESS, one should be mindful of the potential placebo effect of an operation, but as all our patients had been operated on, this could be said to negate this possibility. Unfortunately, information on a small number of patients was incomplete, and resulted in a reduction in the data available for analysis.

Clinicians who assess patients with OSA for maxillomandibular advancement can be reassured that long-term use of CPAP does not seem to have an adverse effect on objective outcomes (AHI and lowest oxygen saturation) after operation. On subjective outcome measures (ESS), this group of patients seemed to do better than those who had used CPAP for a shorter time.

Conflict of interest statement

We have no conflicts of interest.

Ethics statement

None declared.

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